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# An Algorithm of the Target Detection and Tracking of the Video

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**Abstract**

Target detection and tracking of the video is an important part of intelligent monitoring system. This paper proposes an algorithm which uses the matching trajectory to realize the target tracking which based on the Gaussian mixture model. Firstly we use background subtraction to detect the target. Secondly, the feature of the color information, position information, shape information and modified Hough arithmetic are used to find the matching trajectory. At last, we get the result of target tracking. Experimental result shows the method has shorter matching time based on the good detection rate in target detection and tracking.



*Keywords- Gaussian mixture model; HSV- color matching; Hough; target tracking.*

## 1. Introduction

In the intelligent monitoring system, the target detection and tracking is a key technology. To detect the target, we use methods such as background subtraction, inter-frame difference and optical flow [1]. In target tracking, there are many methods such as feature tracking method, dynamic contour tracking method, model-tracking, tracking based on the region [2] and so on. In this paper, we propose an algorithm for detection and tracking the target. Gaussian mixture model is used to establish the background model, the background difference method is used to detect target; target location features, and color features, shape features and modified Hough transform are combined to track the target. With this algorithm, based on the good detection rate, the matching time is shorter.

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## 2. Algorithm of tracking

This paper puts forward to a new algorithm that detects target by combining mixture Gaussian background model and background subtraction, and detects the target accurately. We reduce the K value to curtail the target detection time, and the system's real-time performance has been improved. By detecting the location and colour characteristics of the target, we use the improved Hough transform to detect the shape of the target, then we find the matching target trajectory and achieve the purpose of accurately tracking target. The algorithm flow chart is shown in figure 1.

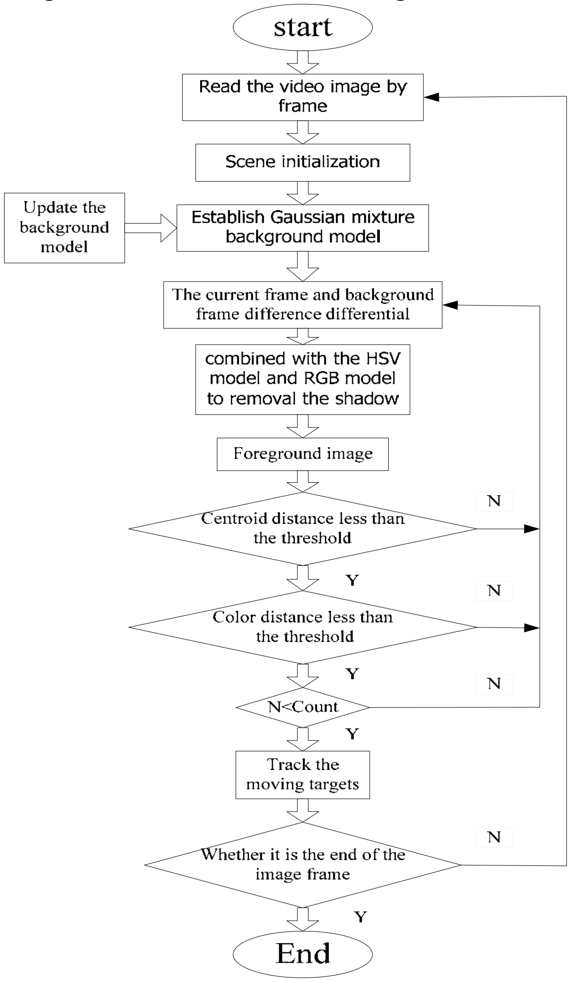



Fig 1. Algorithm flow chart

## 3. Detection and tracking

### *3.1 Moving object detection*

1) Establish Gaussian mixture model: For any color pixel of image background(x, y), in any time the observations for t is $X_t$, the probability model of the pixel [3] is

$$P(X_t) = \sum_{i=1}^{k} X_{i,t} G(X_t, u_{i,t}, N_{i,t}) \tag{1}$$

$G(X_t, u_{it}, N_{it})$ is Gaussian distribution probability function of the pixel, $X_{i,t}$ expresses the i-th Gaussian distribution weight at time t. K general value for 3 to 7, the value is greater, the precision of estimates for background is higher, but it will have the larger computation. On the purpose of the real-time, the paper select 4 for K value. $u_{i,t} = (u^r_{i,t}, u^g_{i,t}, u^b_{i,t})$ is i-th Gaussian distribution of mean vector. $N_{i,t}$ covariance matrix[4]. Parameters are updated to follow the following rules:

$$Q = AG(X_t | u_{i,t-1}, N_{i,t-1}) \tag{2}$$

$$X_{i,t} = (1 - A) X_{i,t-1} + A(M_{i,t}) \tag{3}$$

A, Q is the update of the learning rate, matching $M_{i,t}=1$, otherwise $M_{i,t}=0$. In this paper, in order to obtain a stable background model, we use the background subtraction method to extract the target, and we need to select a smaller learning rate A.

2) The extraction of target: We use the current frame and Gaussian mixture background of the current goal differential for the extraction, the characteristics of parameters are used to distinguish the target and background which is RGB and HSV. For any point (x,y) on the current frame, its RGB component value difference exceeds a certain threshold from three sub-value, then judges the point belongs to target information[5], B（x， y）is binary image after differential.

$$if\ |R_b - R_f| + |G_b - G_f| + |B_b - B_f| / T_{rgb} \tag{4}$$

$$B(x, y) = 1 \tag{5}$$

The Gaussian weights are updated accordingly:

$$else B(x, y) = 0 \tag{6}$$

HSV model used to remove the shadow, for the front target point (x,y) on the binary image, if

$$|H_b - H_f| < T_h \tag{7}$$

$$|S_b - S_f| < T_s$$

$$T_V < V_f < V_b$$

$$\text{then } B(x, y) = 0 \tag{8}$$

The target detection effect is shown in figure 2(b).

*3.2 Target tracking*

The core of the target tracking is the target feature matching. A target chain is established to match the target at different time.Each target chain contains the feature information of the target at different times [6]. The new target detected from the current frame was matched with chain that has been established before, thus the target chain is created, updated and deleted. Then the target tracking is achieved [7]. The paper adopts the centroid matching, HSV color matching and shape outline feature matching method of combining to the target match.

1) Feature matching: The current frame detected N new goals, which contains the centric coordinates （$x_0$， $y_0$）, centroid matching is defined as

$$m_d = \begin{cases} 1 - d_{distance} / T_d & if\ d_{distance} < T_d \\ 0 & if\ d_{distance} > T_d \end{cases} \tag{9}$$

$0<m_d<1$, if the greater $m_d$, we indicate that the target is more matched [8]. $T_d$ is the threshold value to determine the distance. When the centroid distance is larger than the threshold value, we determine the target does not match. Another part of the matching in this paper is HSV color feature matching.

According to the HSV color space color features, we do 36 level of non-uniform quantization for the HSV color space, and the quantitative results are used as match characteristics of the target. Two Euclidean distance h(c) and $h_c(c)$ of the target histogram [9] is

$$d_{hsv} = \left\{ \underset{c=0}{\overset{36}{E}} [h(c) - hc(c)]^2 \right\}^{1/2} \tag{10}$$

$0 < d_{hsv} < 1$, defined HSV histogram for matching degree as

$$m_d = \begin{cases} 1 - d_{distance} / T_d & if \ d_{distance} < T_d \\ 0 & if \ d_{distance} > T_d \end{cases} \qquad 0 < m_{hsv} < 1 \tag{11}$$

If $m_{hsv}$ is greater, the target is more matched. When the color range beyond the threshold value, the target will not be matched.

2) Target tracking process: Target tracking mainly includes three steps： The target chain is established, the target chain is updated and the target chain is canceled [10]. If a target does not be matched in the chain for N times, then we think that this target has been leave the target chain, so we remove the target chain, and the tracking process is end.

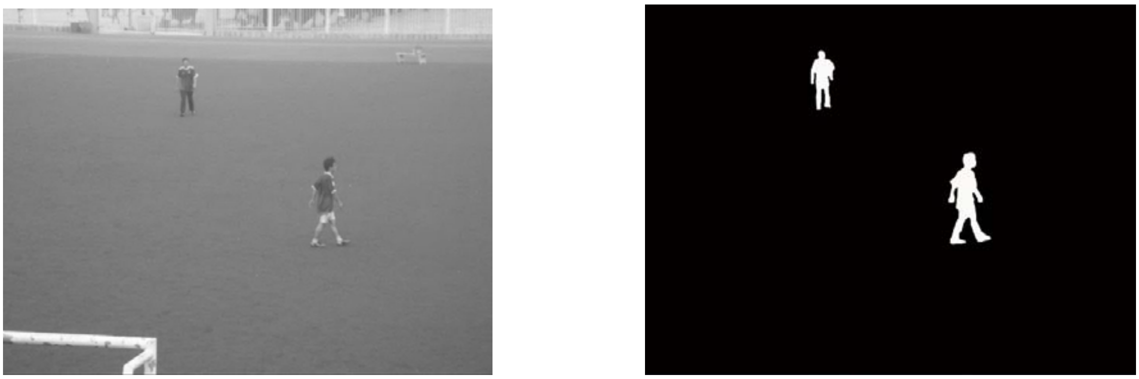
## 4. Test results

In order to verify the effectiveness of the algorithm, we do simulation experiments in Matlab environment for the algorithm. Experimental platform is the AMD5200 + 2.70G Hz 180G 2G memory computer; we did tracking test for three two-minute videos segment of students who playing football on the playground. The tracking effect is shown in figure2(c)and(d); Compared with the Mean-shift tracking algorithm, the detection rate and average processing time per frame as shown in table 1.

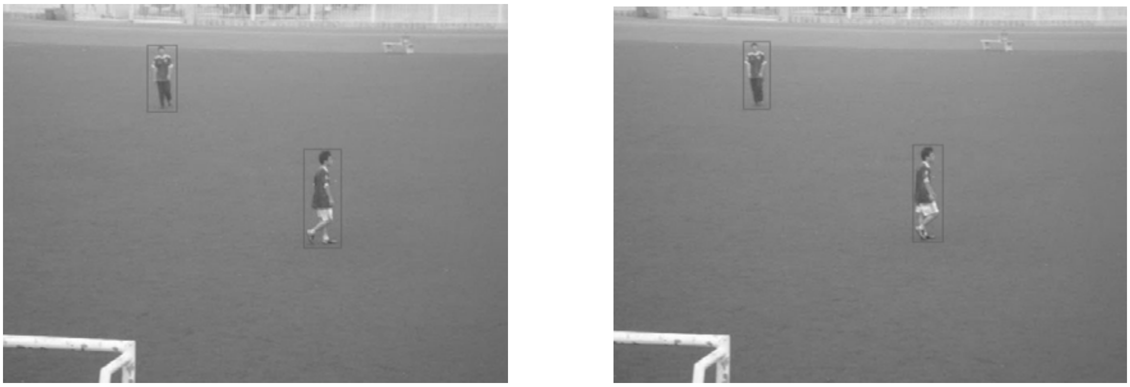
It can be seen that Mean-shift algorithm (algorithm 1) and the algorithm in this paper(algorithm 2) can both effectively keep tracking all athletes when target number is not too much. With a large number of targets, the detection rate of algorithm 2 is slightly lower than algorithm 1, but no matter what kind of environment, the average processing time for per frame of algorithm 2 is less than the processing time for per frame of algorithm 1.Therefore, algorithm 1 has better real-time application.

Table 1. Algorithm test results of comparison

| | number of targets | Mean-shift algorithm | | | The algorithm in this paper | | |
|---|---|---|---|---|---|---|---|
| | | Accurate tracking | Detection rate | ms/frame | Accurate tracking | Detection rate | ms/frame |
| Video section 1 | 12 | 12 | 100% | 52 | 12 | 100% | 45 |
| Video section 2 | 9 | 9 | 100% | 48 | 9 | 100% | 43 |
| Video section 3 | 36 | 34 | 94.44% | 56 | 33 | 91.67% | 47 |



(a) (b)



(c) (d)

Fig 2: Tracking results: (a) Original figure. (b) Renderings of detection targets. (c) Dynamic tracking results of 25th frame. (d) Dynamic tracking results of 29th frame

## 5. Conclusions

Experiments show this algorithm has better results when we use it in detecting and tracking targets. This algorithm is suitable for the real-time target tracking. But there are still some shortcomings, such as it can not track the targets well when the number of the targets is large, this is the focus of the further research work.

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